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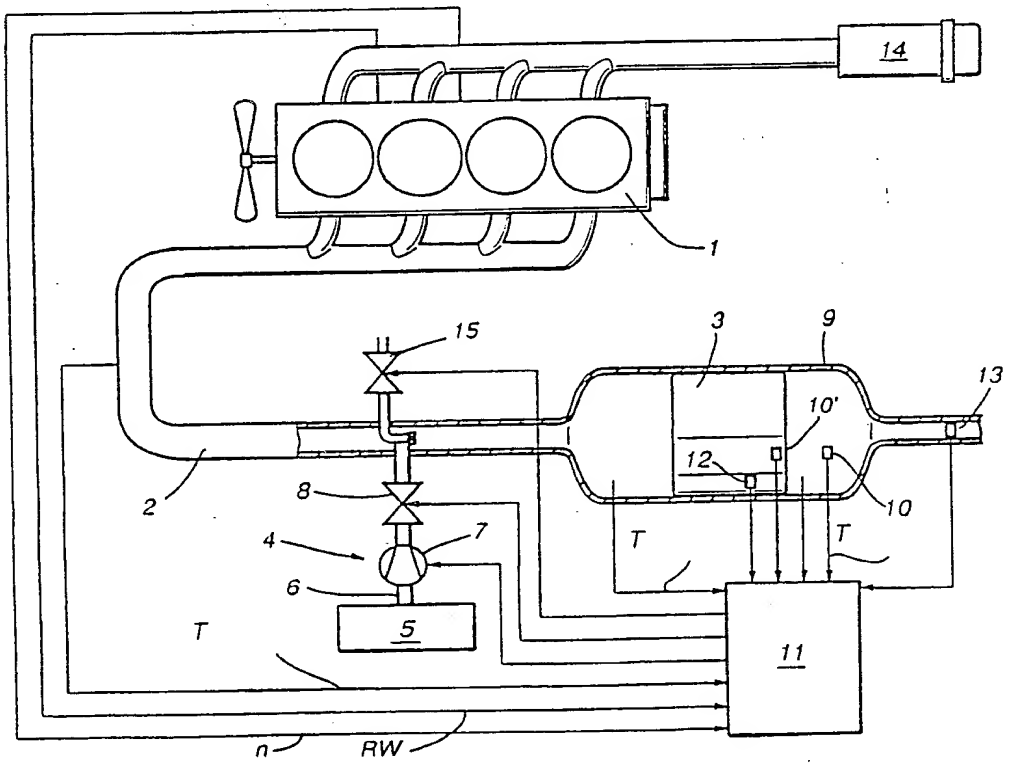
(54) Exhaust gas treatment system

(57) In an ic engine exhaust gas treatment system a catalyst 3 is supplied with an overstoichiometric quantity of ammonia to reduce nitrous oxides. The pump 7 supplying ammonia is shut off when a sensor 10 detects that the concentration of ammonia in the exhaust gases reaches an upper threshold level and is resumed when a second sensor determines that quantity of ammonia adsorbed in the catalyst reaches a second, lower threshold.

In a second embodiment the output of a single sensor 13 is compared with a reference value to form a correction signal used for triggering the metering appliance 4 which is continuously connected into the gaseous phase.



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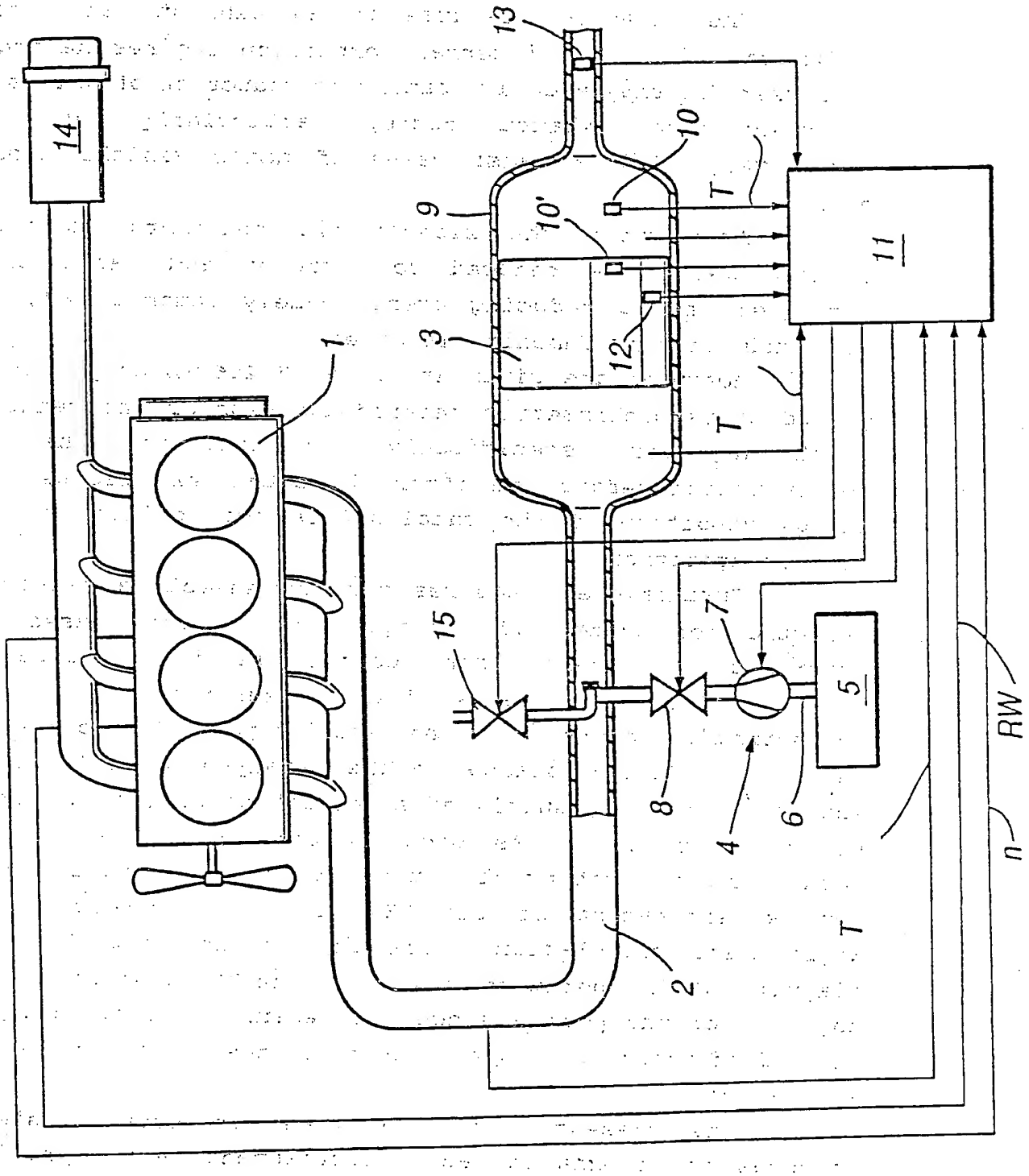
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Exhaust gas aftertreatment device for internal combustion engines

The invention relates to an exhaust gas aftertreatment device for internal combustion engines having a catalyser for the selective catalytic reduction of oxides of nitrogen from exhaust gases, particularly but not exclusively, from exhaust gases of motor vehicle diesel engines.

As is known, the oxides of nitrogen contained in the exhaust gases are reduced to nitrogen and water on a catalyser when a reducing agent, namely ammonia (NH_3) or compounds forming ammonia, is added.

Measures are given in DE 38 25 206 which provide a pulsed overstoichiometric metered addition of the reducing agent NH_3 and, specifically, by measuring the NO_x concentration before and after the catalyser, because the charge condition of the catalyser is not defined in this mode of operation.

Furthermore, measures for the selective catalytic reduction of oxides of nitrogen from exhaust gases are described in the older German Patent Application P 41 17 143.8-43, by means of which measures the high NH_3 concentration occurring in the metering phase is recorded by means of a sensor placed in the catalyser, which sensor interrupts the NH_3 supply after detection of the specified NH_3 concentration. As soon as the NH_3 stored in the catalyser is substantially used up by the reaction, the renewed employment of the NH_3 supply is determined by approximate calculation, from the engine characteristic diagram and the operating period, of the NO_x produced by the engine over the period since the beginning of metering or the end of metering, taking account of the average degree of separation.

The present invention seeks to provide simple measures on an exhaust gas aftertreatment device provided

for internal combustion engines, these measures permitting a further improvement with respect to the reduction of the oxides of nitrogen contained in the exhaust gas.

According to one aspect of the present invention there is provided an exhaust gas aftertreatment device for internal combustion engines having a catalyser for the selective catalytic reduction of oxides of nitrogen from exhaust gases, having a metering appliance for the overstoichiometric supply of NH_3 or materials releasing NH_3, having at least two sensors, of which one, an NH_3 sensor, interrupts the supply when the NH_3 quantity exceeds a specified upper threshold value, and having means by which the supply resumes whenever, in the catalyser, a stored NH_3 quantity reaches a specified lower threshold value, wherein the second sensor is configured as an NH_3 sensor recognising the lower threshold value of the stored NH_3 quantity.

Preferably, the first NH_3 sensor intended for the upper threshold value and the second NH_3 sensor intended for the lower threshold value are arranged in the catalyser, of which sensors the first NH_3 sensor measures the NH_3 concentration in the exhaust gas and the second NH_3 sensor measures the NH_3 adsorbed in the catalyser.

Alternatively, the second NH_3 sensor is arranged in the catalyser and the first NH_3 sensor is arranged downstream of the catalyser, of which sensors the first NH_3 sensor measures the NH_3 concentration in the exhaust gas and the second NH_3 sensor measures the NH_3 adsorbed in the catalyser.

According to a second aspect of the invention there is provided an exhaust gas aftertreatment device for internal combustion engines having a catalyser for the selective catalytic reduction of oxides of nitrogen from exhaust gases, having a metering appliance for the supply of NH_3 or the supply of materials releasing NH_3, having a sensor for determining the NH_3 concentration in the exhaust gas, wherein the supply of NH_3 is provided in the gas phase without metering pauses in such a way that the NH_3

concentration recorded by the sensor is compared, as the actual value, with a required value corresponding to a specified NH_3 concentration in order to form a correction signal which is used for triggering the metering appliance continuously connected into the gas phase.

Preferably, the sensor is placed downstream of the catalyser or in the catalyser itself.

Preferably, the device is adapted to treat the exhaust gas of a diesel engine.

Due to the measures according to the invention, it is not necessary to calculate the level of charge in the catalyser during the metering pause or NH_3 interruption phase on the basis of the characteristic diagram. The matching of the NH_3 supply to the various engine types with very different exhaust gas emissions becomes superfluous and it is not necessary to take account of the unavoidable component scatter within a type in the selection of the level limits. In accordance with the first aspect of the invention, a second ammonia sensor, which detects the ammonia adsorbed in the catalyser, undertakes the recognition of the lower level of charge whereas the first ammonia sensor detects gaseous ammonia.

This first NH_3 sensor can be placed either downstream of the catalyser or in the catalyser itself. Although the arrangement of the sensor within the catalyser does not permit an optimum utilisation of the catalyser volume, it does ensure that the NO_x emissions do not exceed the permissible limiting values. On the other hand, the arrangement of the sensor after the catalyser does permit full utilisation of the catalyser volume for the maximum adsorption capacity, but a brief minimum unallowable NH_3 break-out cannot always be excluded.

Although a special embodiment with a second sensor is described in the publication (P 41 17 143.8-43), this is subjected to exhaust gas upstream of the catalyser.

Continuous control of a slight, but constant NH_3 slip within permissible limiting values is possible by means

of the measures, in accordance with the second aspect of the invention. The advantage of this embodiment lies in the disappearance of any type of characteristic diagram and in the compensation for any changes to the engine and the catalyser within the control range.

The invention will now be explained in more detail using an embodiment shown in the drawing.

In the drawing, an internal combustion engine is indicated by reference 1, an exhaust gas conduit by reference 2, a catalyser by reference 3 and a metering appliance by reference 4, which appliance comprises a reducing agent tank 5 and a supply conduit 6 with a delivery pump 7 and a shut-off valve 8. The supply conduit 6 opens into the exhaust gas conduit 2 upstream of the catalyser 3.

The reducing agent tank 5 contains ammonia (NH_3) or materials releasing ammonia, which are supplied in a controlled manner to the exhaust gas flow in the exhaust gas conduit 2.

The catalyser 3 is arranged in a casing 9 in which a first NH_3 sensor 10 is provided downstream of the catalyser 3. This NH_3 sensor 10 measures the NH_3 concentration in the exhaust gas and feeds a switching signal into a control unit 11 at a time when the gaseous NH_3 quantity has reached a fixed upper threshold value. The control unit 11 controls the delivery pump 7 in the sense of switching it off so that the NH_3 supply is interrupted.

A second NH_3 sensor 12 is arranged in, for example, carrier material of the catalyser 3 which detects adsorbed NH_3. As soon as the lower level limit is reached in the catalyser 3 and the NH_3 stored in the catalyser has been substantially consumed by reaction, a switch signal corresponding to the fixed lower NH_3 threshold value is supplied to the control unit 11. The control unit 11 controls the delivery pump 7 in the sense of switching it on again and metered addition of NH_3 is resumed and, in fact, as a function of operating parameters. Engine rotational speed n, control distance CD, exhaust gas temperature

$T_{exhaust}$ upstream of the NH_3 supply and exhaust gas temperatures at inlet, $T_{cat.in}$, and outlet, $T_{cat.out}$, of the catalyser 3 are provided as parameters.

During the metering pause, the shut-off valve 8 triggered by the control unit 11 shuts off the supply conduit 6, into which no exhaust gas can flow.

The first NH_3 sensor 10 can, however, also be placed in the catalyser 3, which sensor - in contrast to the second NH_3 sensor 12 - measures gaseous NH_3 and is indicated by 10'.

A further embodiment, but for continuous control of the metering appliance 4, is provided by the arrangement of a single NH_3 sensor 13 downstream of the catalyser 3. It is also possible to place this NH_3 sensor 13 in the catalyser 3 itself.

The sensor 13 determines the respective NH_3 concentration in the gas phase. The instantaneously present NH_3 concentration is compared, as the actual value, with a required value corresponding to a specified NH_3 concentration and a correction signal formed from this is used for triggering the metering appliance 4. The continuous control provides an ammonia slip, within the permissible limiting values, which is as small as possible and constant.

An air filter and a compressed air valve are, in addition, respectively indicated by references 14 and 15 in the drawing.

Claims

1. An exhaust gas aftertreatment device for internal combustion engines having a catalyser for the selective catalytic reduction of oxides of nitrogen from exhaust gases, having a metering appliance for the overstoichiometric supply of NH_3 or materials releasing NH_3, having at least two sensors, of which one, an NH_3 sensor, interrupts the supply when the NH_3 quantity exceeds a specified upper threshold value, and having means by which the supply resumes whenever, in the catalyser, a stored NH_3 quantity reaches a specified lower threshold value, wherein the second sensor is configured as an NH_3 sensor recognising the lower threshold value of the stored NH_3 quantity.

2. An exhaust gas aftertreatment device according to Claim 1, wherein the first NH_3 sensor intended for the upper threshold value and the second NH_3 sensor intended for the lower threshold value are arranged in the catalyser, of which sensors the first NH_3 sensor measures the NH_3 concentration in the exhaust gas and the second NH_3 sensor measures the NH_3 adsorbed in the catalyser.

3. An exhaust gas aftertreatment device according to Claim 1, wherein the second NH_3 sensor is arranged in the catalyser and the first NH_3 sensor is arranged downstream of the catalyser, of which sensors the first NH_3 sensor measures the NH_3 concentration in the exhaust gas and the second NH_3 sensor measures the NH_3 adsorbed in the catalyser.

4. An exhaust gas aftertreatment device for internal combustion engines having a catalyser for the selective catalytic reduction of oxides of nitrogen from exhaust gases, having a metering appliance for the supply of NH_3 or the supply of materials releasing NH_3, having a sensor for

determining the NH_3 concentration in the exhaust gas, wherein the supply of NH_3 is provided in the gas phase without metering pauses in such a way that the NH_3 concentration recorded by the sensor is compared, as the actual value, with a required value corresponding to a specified NH_3 concentration in order to form a correction signal which is used for triggering the metering appliance continuously connected into the gas phase.

5. An exhaust gas aftertreatment device according to Claim 4, wherein the sensor is placed downstream of the catalyser or in the catalyser itself.

6. An exhaust gas aftertreatment device according to any one of claims 1 to 5, wherein the device is adapted to treat the exhaust gas of a diesel engine.

7. An exhaust gas aftertreatment device for internal combustion engines having a catalyser for the selective catalytic reduction of oxides of nitrogen from exhaust gases, substantially as described herein with reference to and as illustrated in the accompanying drawing.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition L) G3R (RBX RBE72 RBE79 RBE99 RBU RAF RD)

(ii) Int Cl (Edition 5) F01N AND B01D

Search Examiner
MR A BARTLETT

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search
14 JULY 1993

Documents considered relevant following a search in respect of claims 1-3

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	EP 0515857 A1 (BASF) whole document	1 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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&: Member of the same patent family, corresponding document.

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